

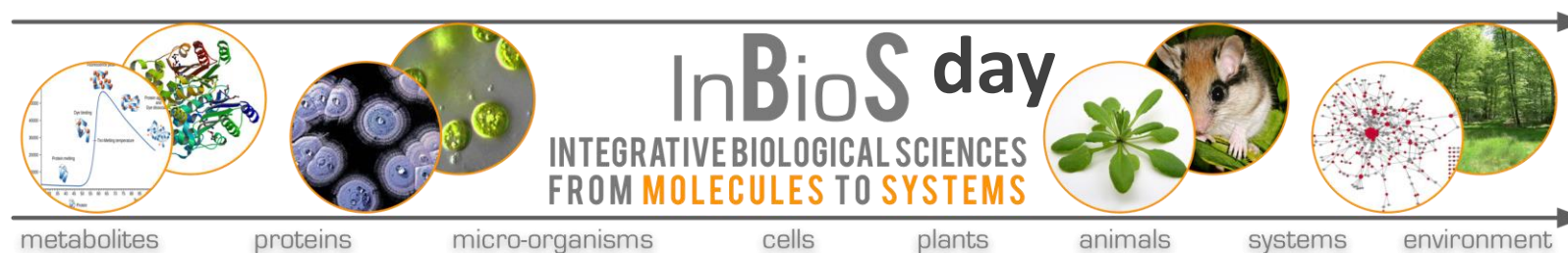
Study of photosynthesis in photo-symbiotic cnidarians

Félix Vega de Luna

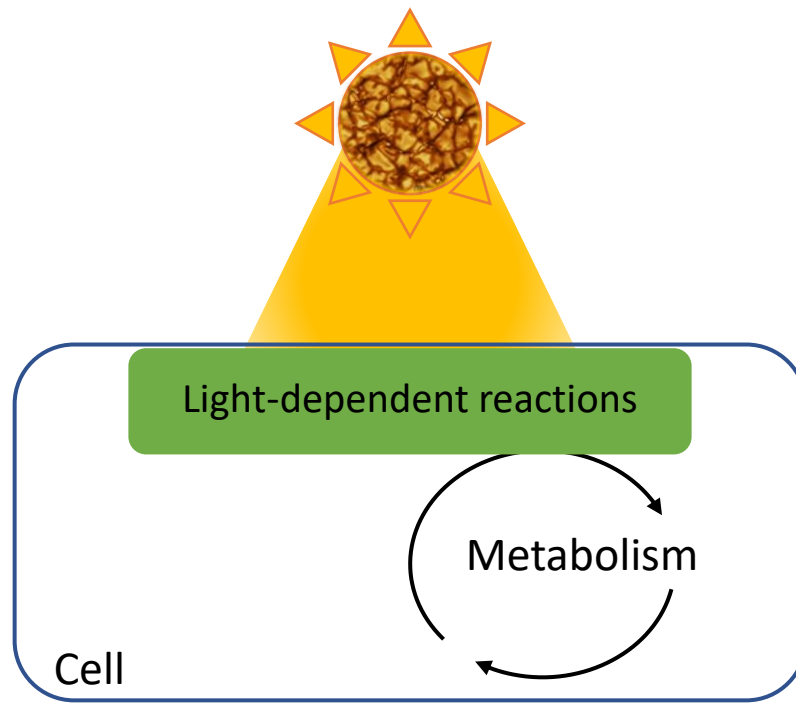
Doctorat de Biochimie, Biologie moléculaire et cellulaire, Bioinformatique et modélisation

Genetics and Physiology of Microalgae – Institute of Botany, B22

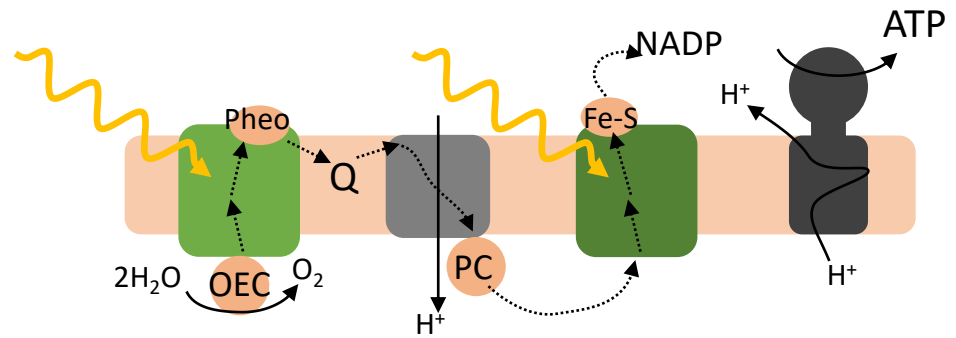
InBioS – Phytosystems





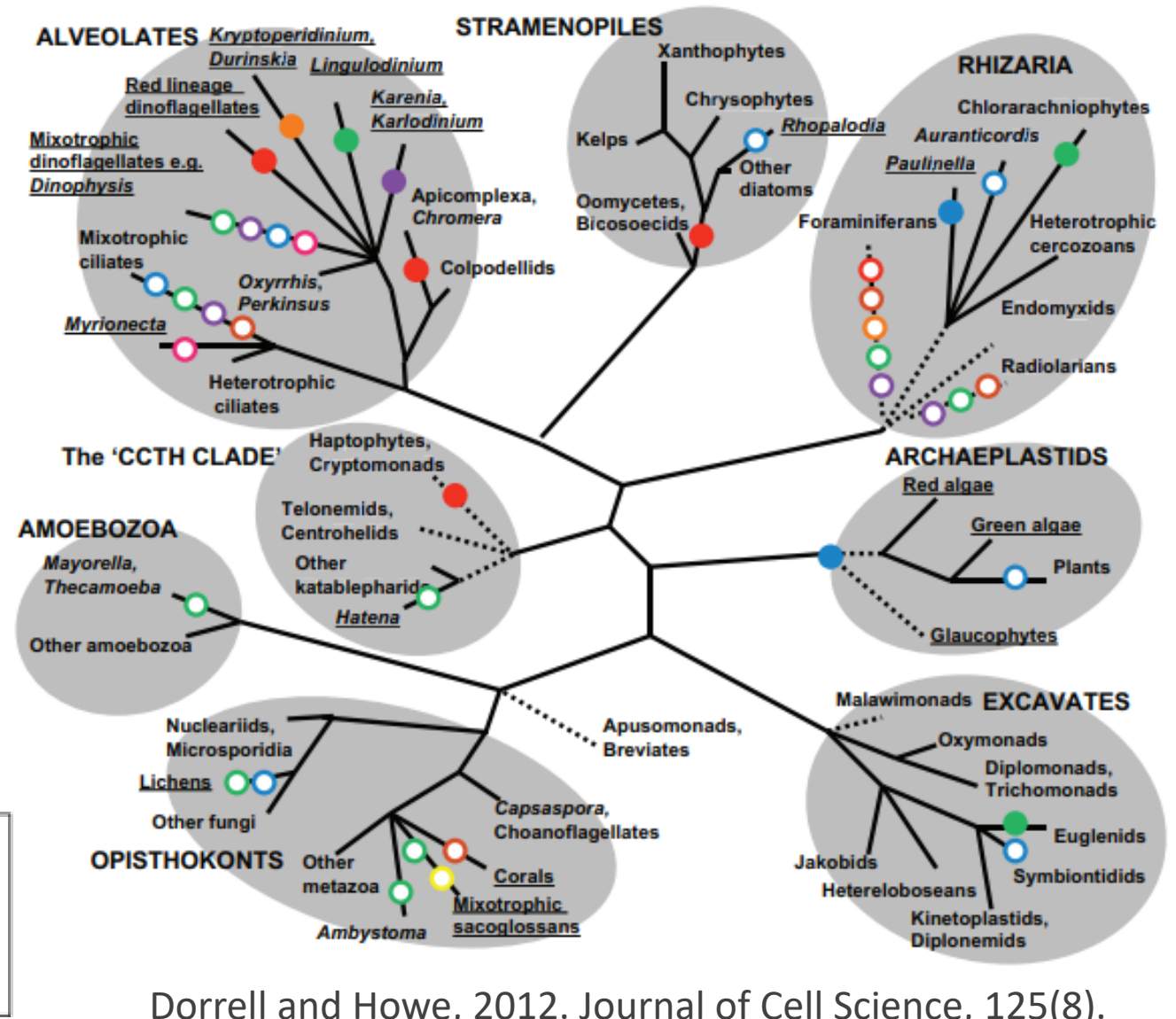


Cyanobacteria
Eukarya



A series of endosymbiont or plastid acquisition events has led to a huge diversity of photosynthetic eukaryotes

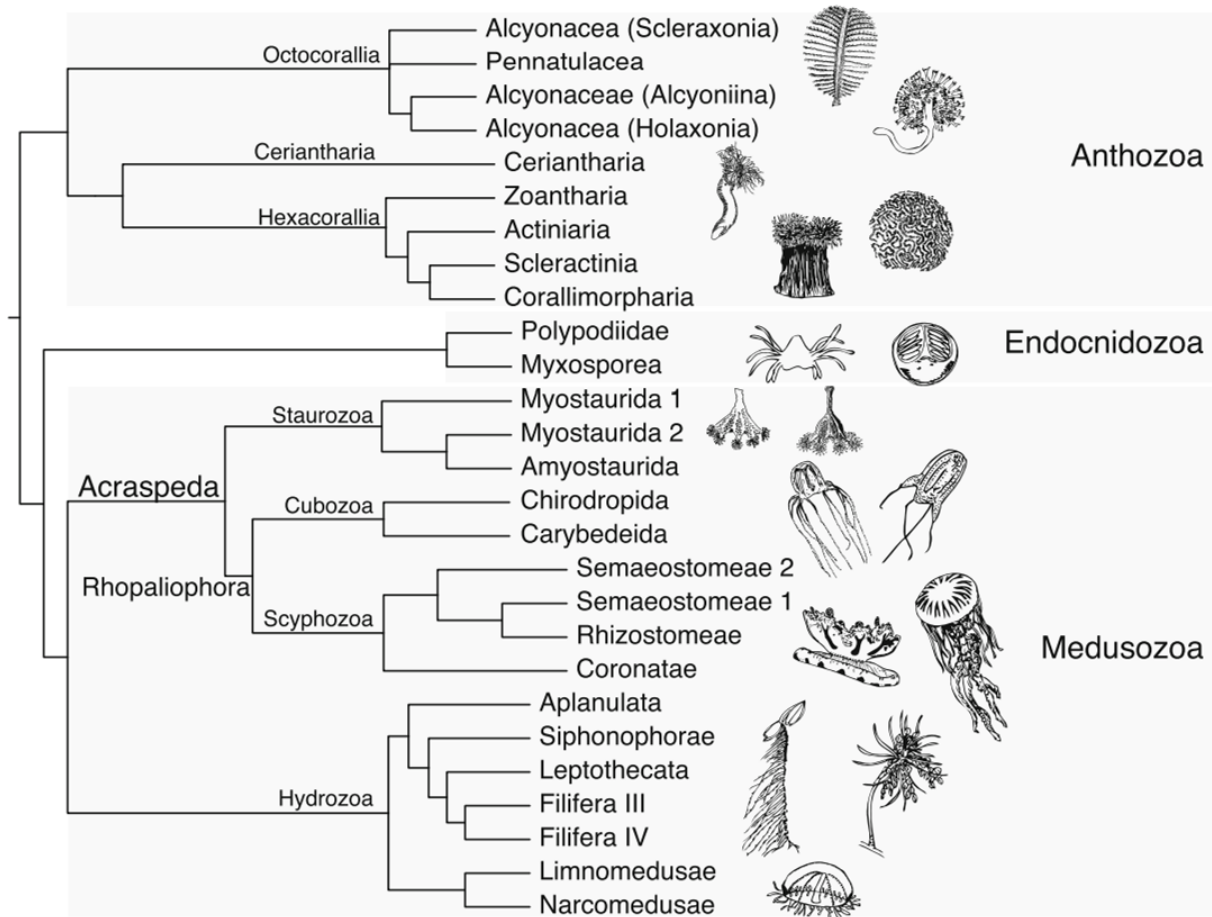
Organelle ≠ Endosymbiont



Dorrell and Howe, 2012. Journal of Cell Science, 125(8).

Cnidarians

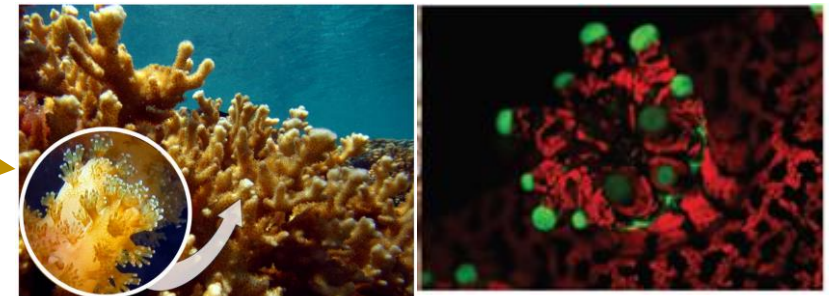
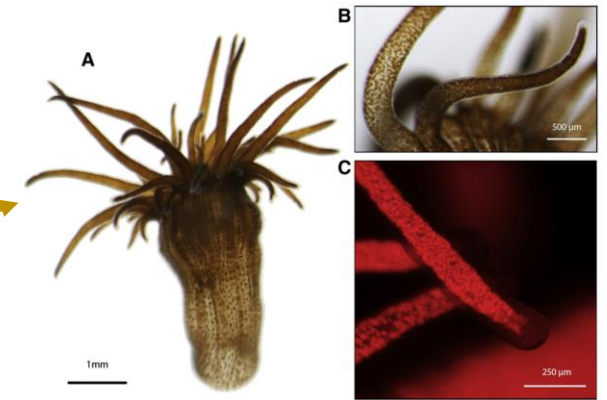
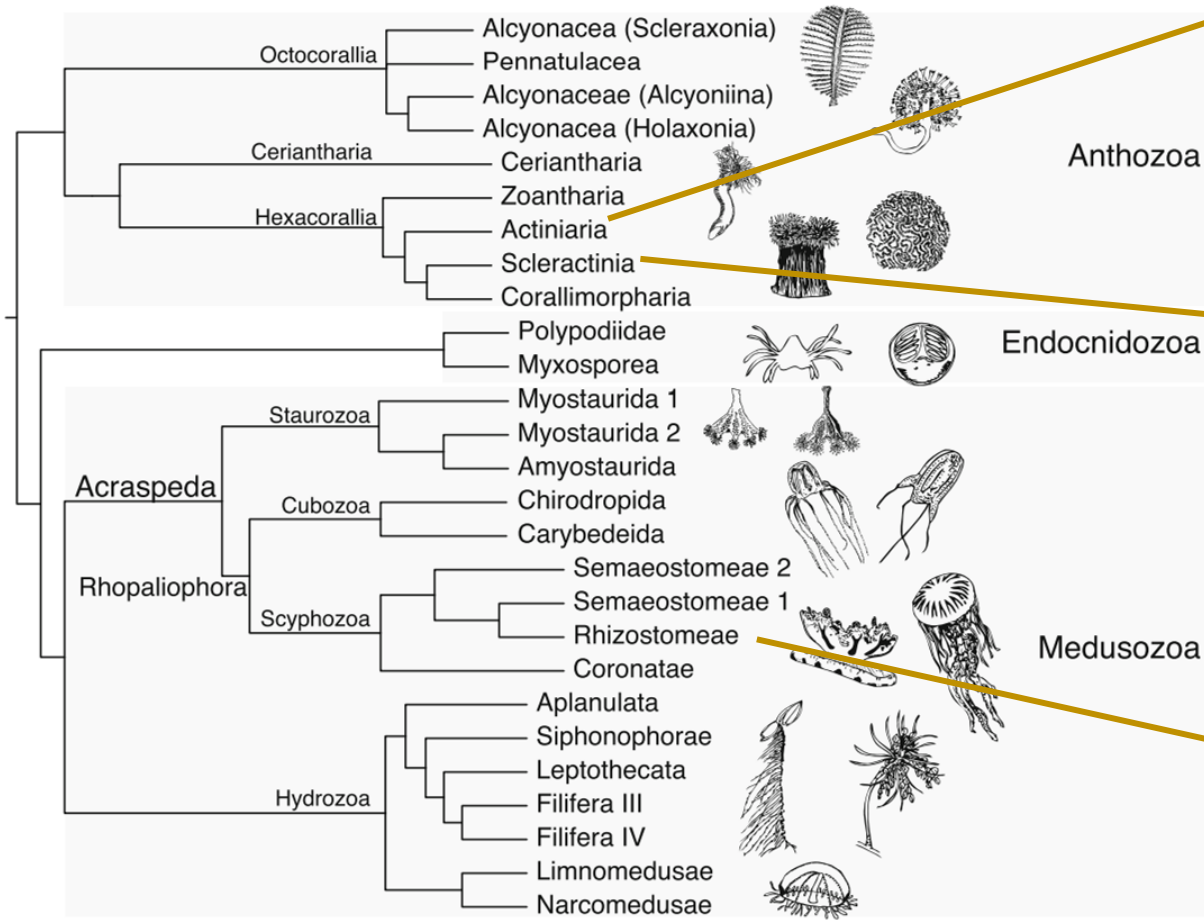
Symbiosis could have evolved several times and independently in cnidarians



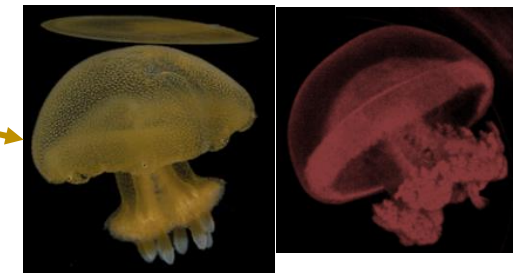
Kayal et al. 2018. BMC Evolutionary Biology, 18:68.

Cnidarians

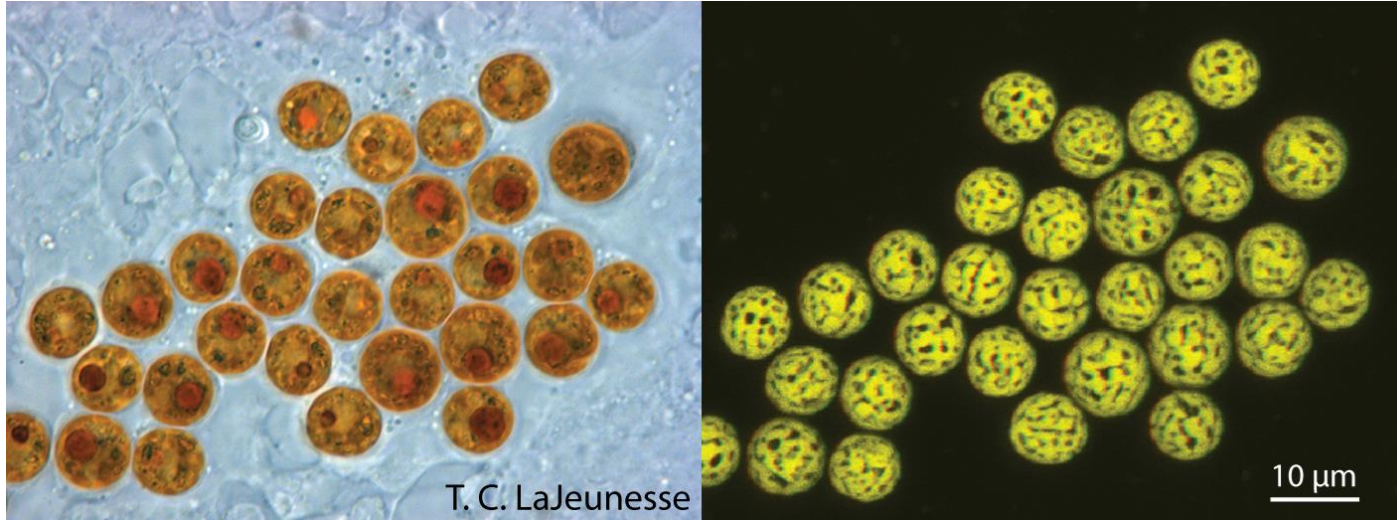
Symbiosis could have evolved several times and independently in cnidarians



Colony of lace coral (*Pocillopora damicornis*, Type 1) with morphology recovered on May 2015. Circle is a zoom of the polyps growing at the tip of the branch. (Credit: David A. Paz-García).



Symbiodiniaceae family



Current Biology

Article

Systematic Revision of Symbiodiniaceae Highlights the Antiquity and Diversity of Coral Endosymbionts

Highlights

- The micro-algal genus *Symbiodinium* is split into multiple genera
- Seven of these genera are formally described based on genetics and ecology
- Dinoflagellates in the family Symbiodiniaceae originated in the Jurassic Period
- Symbiodiniaceae diversification coincided with the radiation of reef-building corals

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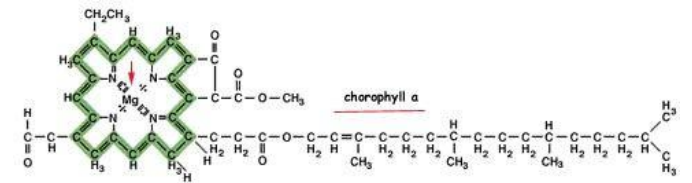
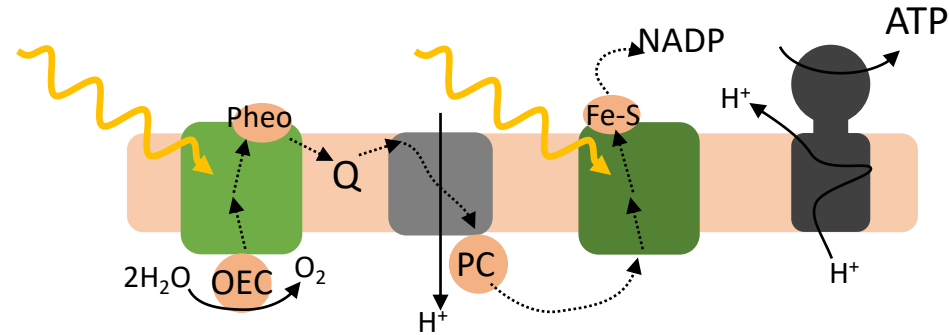
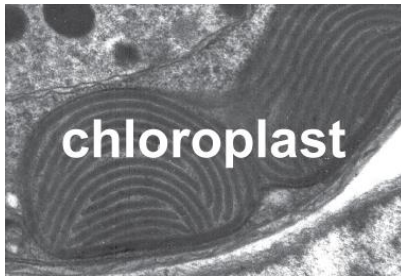
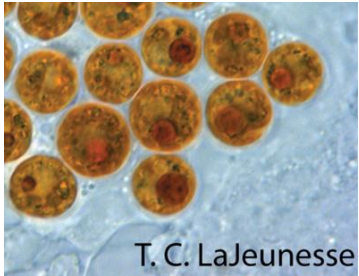
Zooxanthellate Memes for Anthozoan Teens

January 1 at 9:00 AM · 🌐

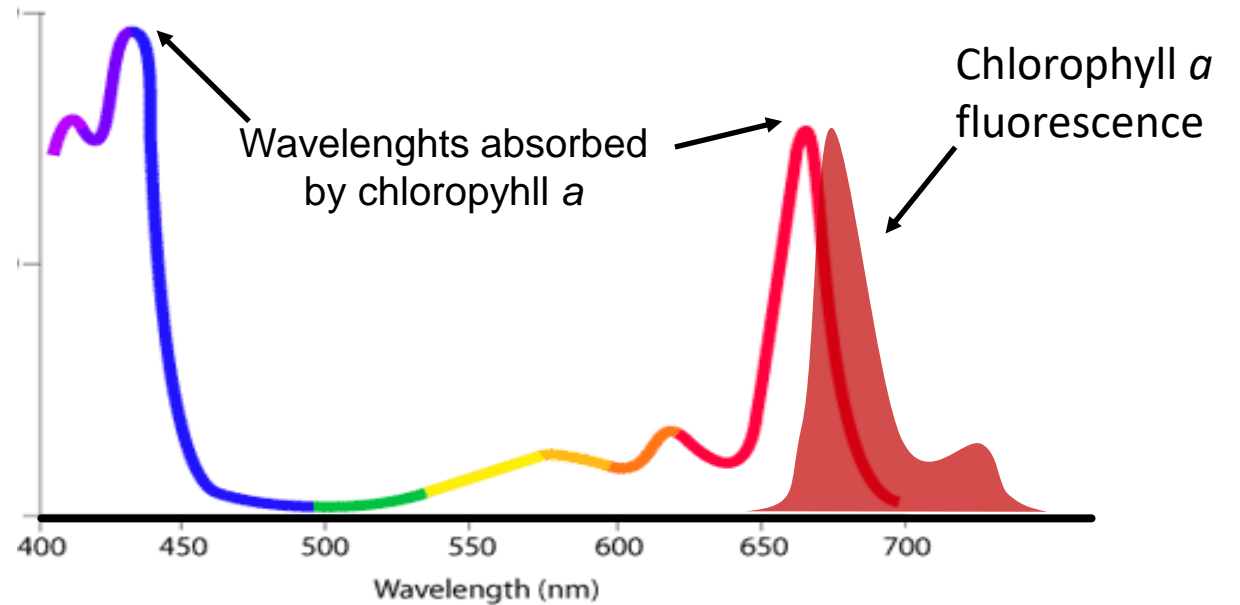
its real taxonomic uncertainty hours



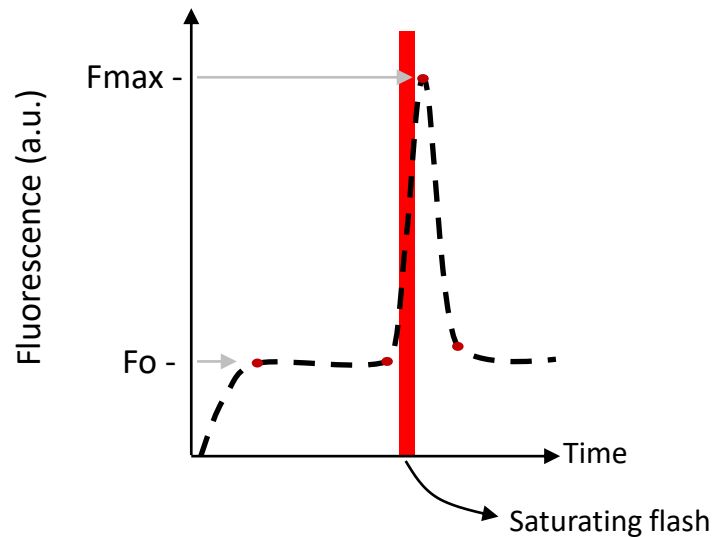
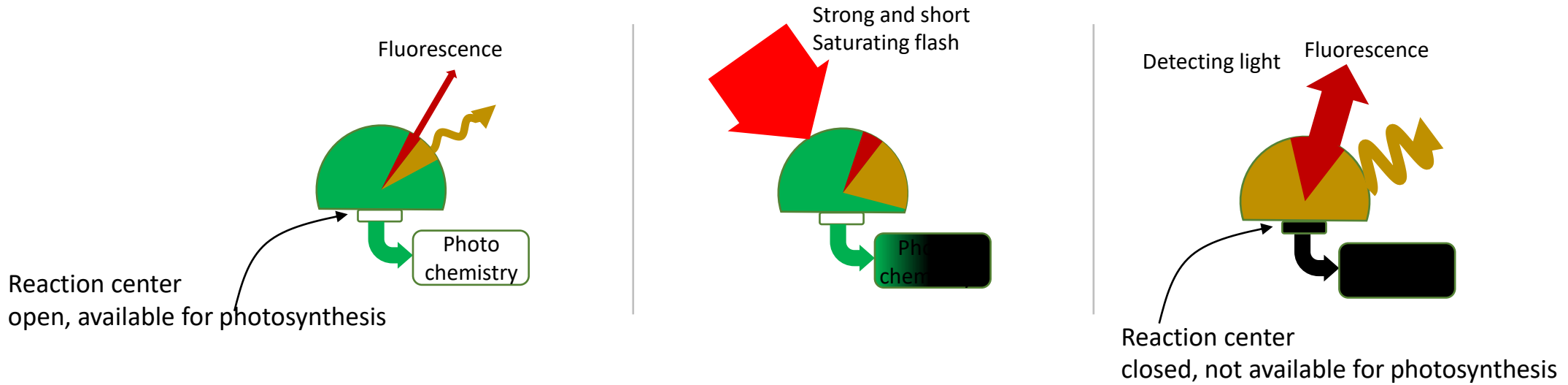
Chlorophyll *a* is one of the main pigments in oxygenic photosynthetic complexes.



It emits fluorescence as a mechanism of de-excitation after radiative energy has been absorbed.



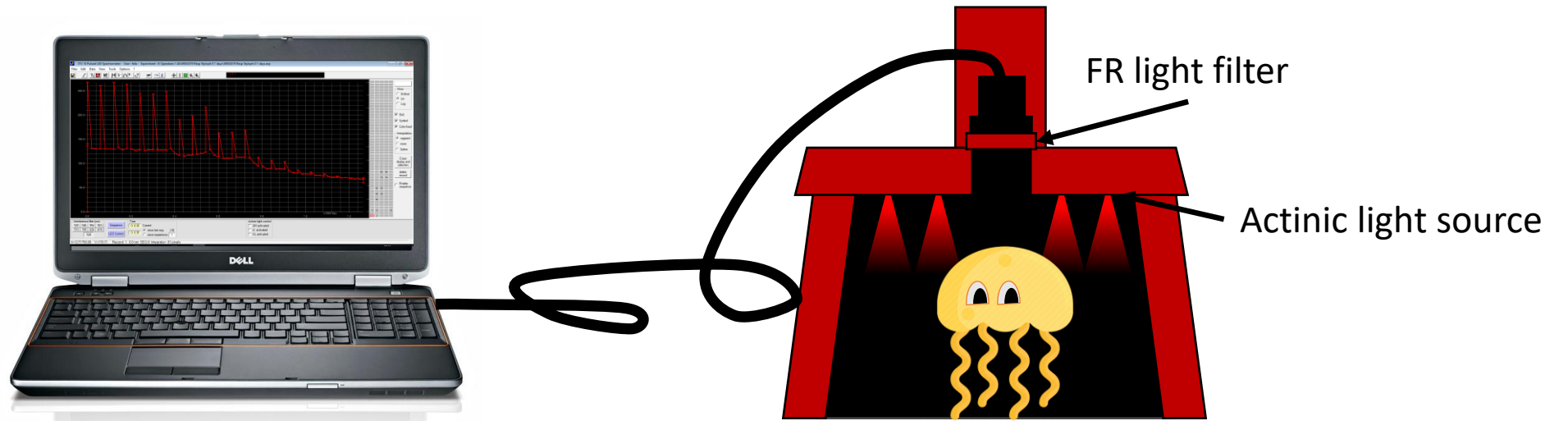
In vivo Chl *a* fluorescence yield is related to photosynthetic capacity



$$\text{Photosynthetic efficiency} = \frac{\text{Available capacity for photochemistry}}{\text{Saturating activity}} = \frac{F_v}{F_m} = \frac{F_{\max} - F_o}{F_{\max}}$$

$$\text{Photosynthetic efficiency under light} * \text{Irradiance} = r \text{ Electron Transfer Rate}$$

Imaging fluorescence camera (SpeedZen camera)



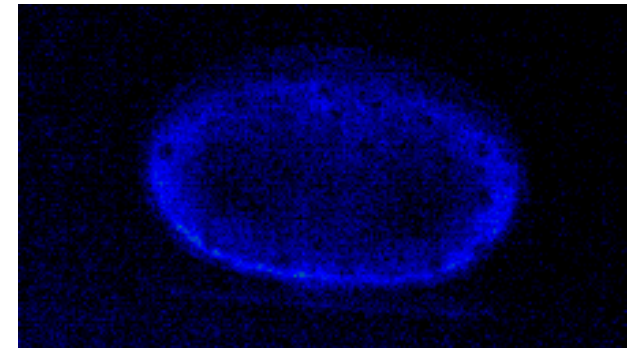
Johnson et al. 2009. Photosynth Res 102.

True color picture

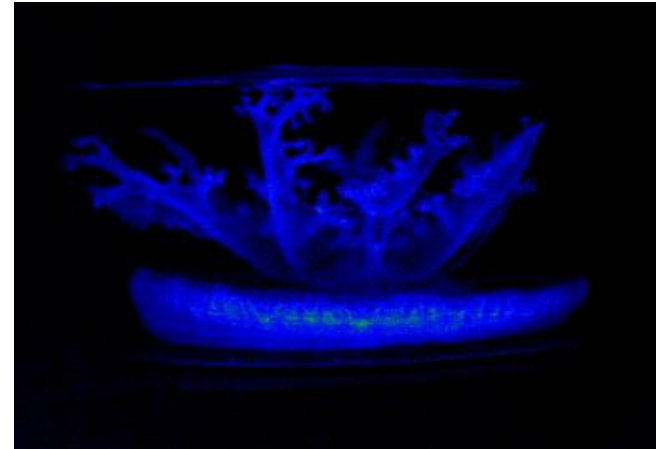


Mastigias papua

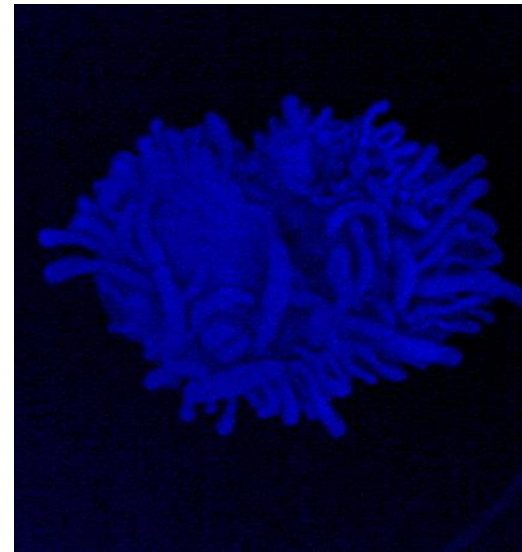
Fluorescence



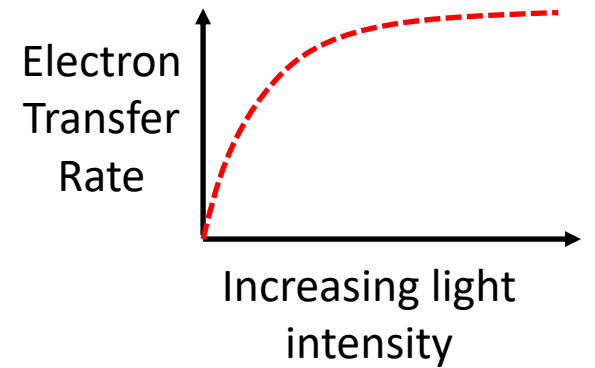
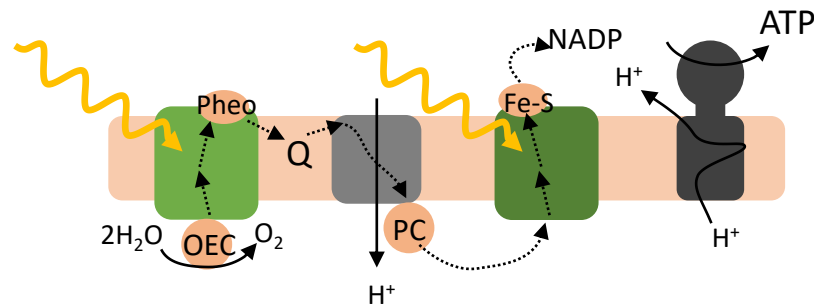
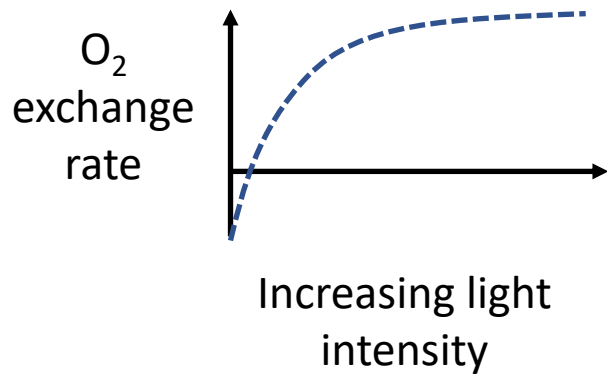
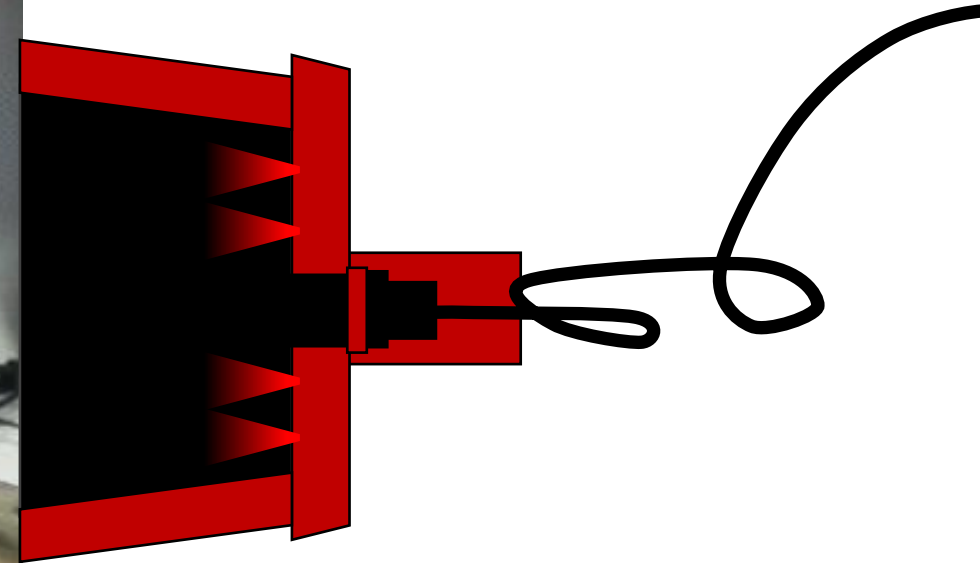
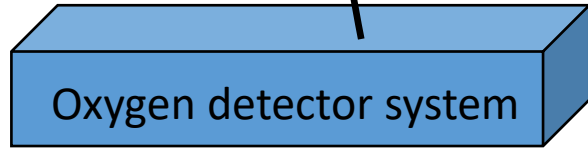
Cassiopea xamana



Entacmaea quadricolor



Oxygen and fluorescence simultaneous acquisition



The Jellyfish Lake in Eil Malk, Palau, used to be inhabited by the golden jellyfish *Mastigias papua*.



<https://commons.wikimedia.org>



Republic of Palau

(Pictures from 2008)



Sampling campaign in 2018 to Palau

(Pictures from 2008)



The Jellyfish Lake in Eil Malk, Palau, used to be inhabited by the golden jellyfish *Mastigias papua*.



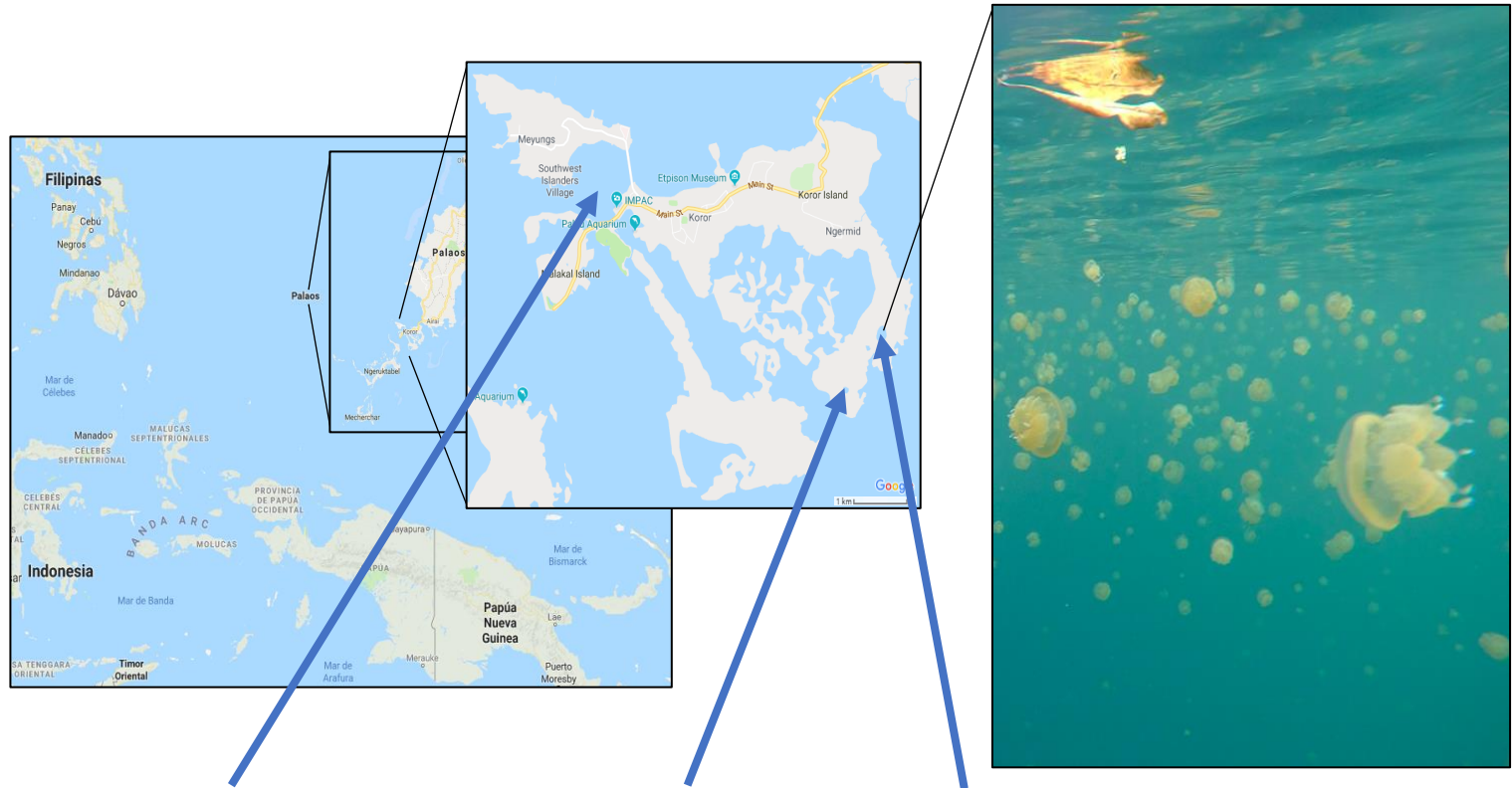
<https://commons.wikimedia.org>



Republic of Palau



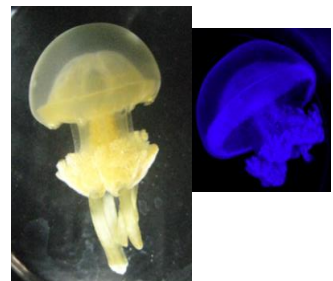
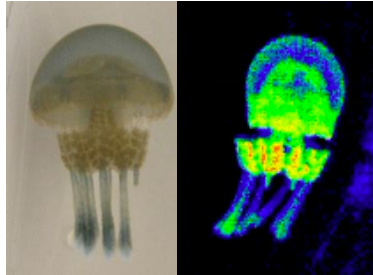
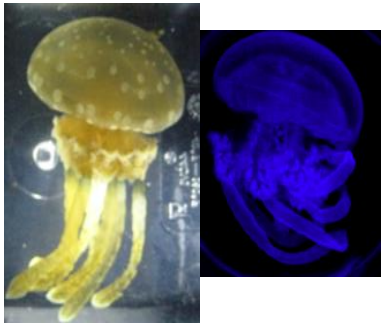
Sampling campaign in 2018 to Palau



Ngerchaol cove (NCK)

Goby lake (GLK)

Uet era Ngermeuangel (NLK)

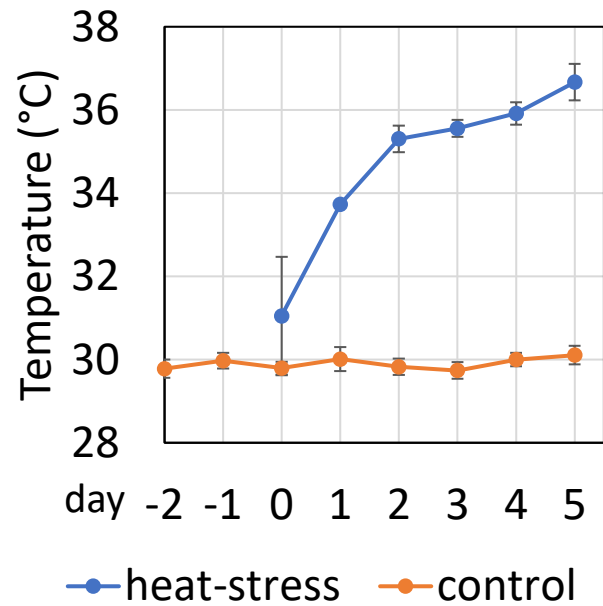


Jellyfishes collected with the help of Gerda Ucharm and Lori Colin (CRRF, Koror, Palau) from the Uet era Ngermeuangel lake (NLK), Goby lake (GLK), and from the Ngerchaol cove (NCK) in January 2018, Palau and analyzed at PICRC, Koror, Palau.

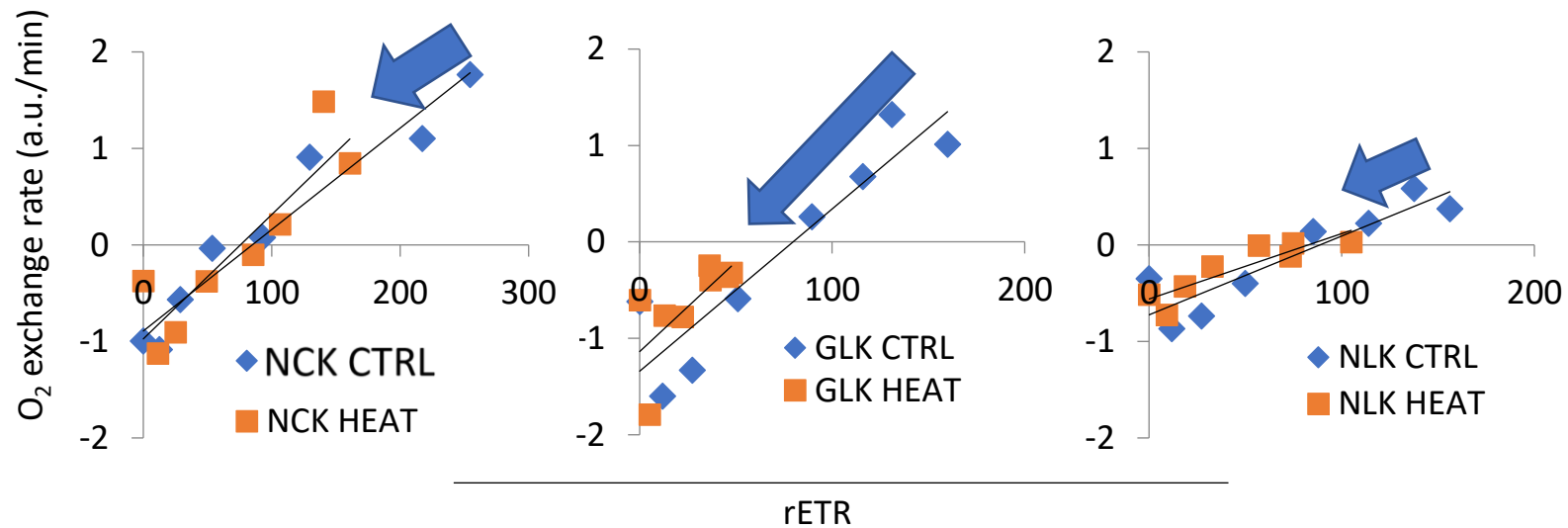
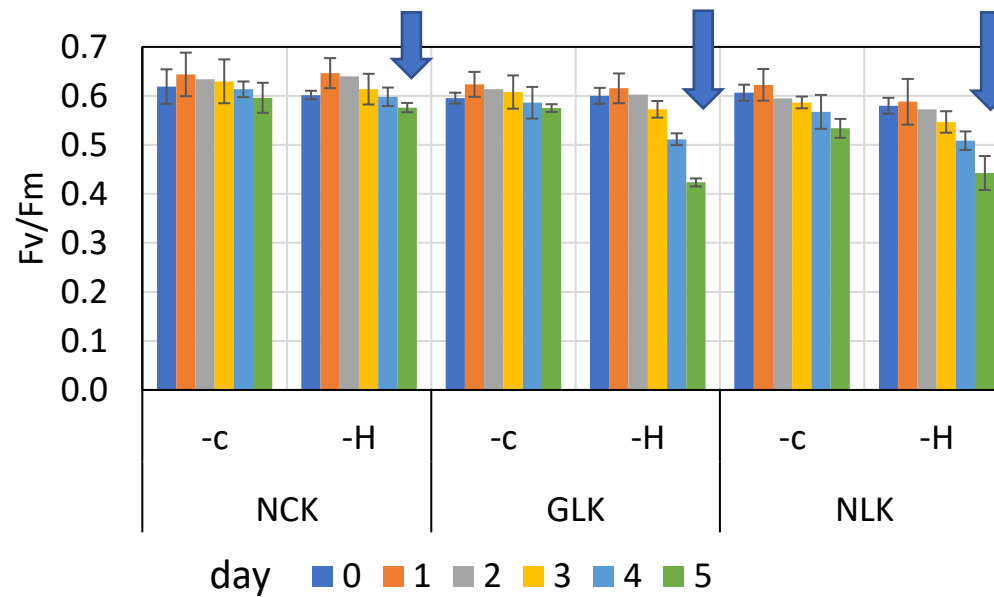
The specimens were maintained in the Palau International Coral Reef Center



Temperature profile of control and heat stress experiment



Maximum quantum yield of PSII



No signs of electron transfer rerouting could be observed.

Other cnidarian species inhabit this lake,
like the anemone *Entacmaea medusivora*



The anemone is azooxanthellated

Fautin and Fitt, 1991. *Hydrobiologia*, 216–217:453–61.

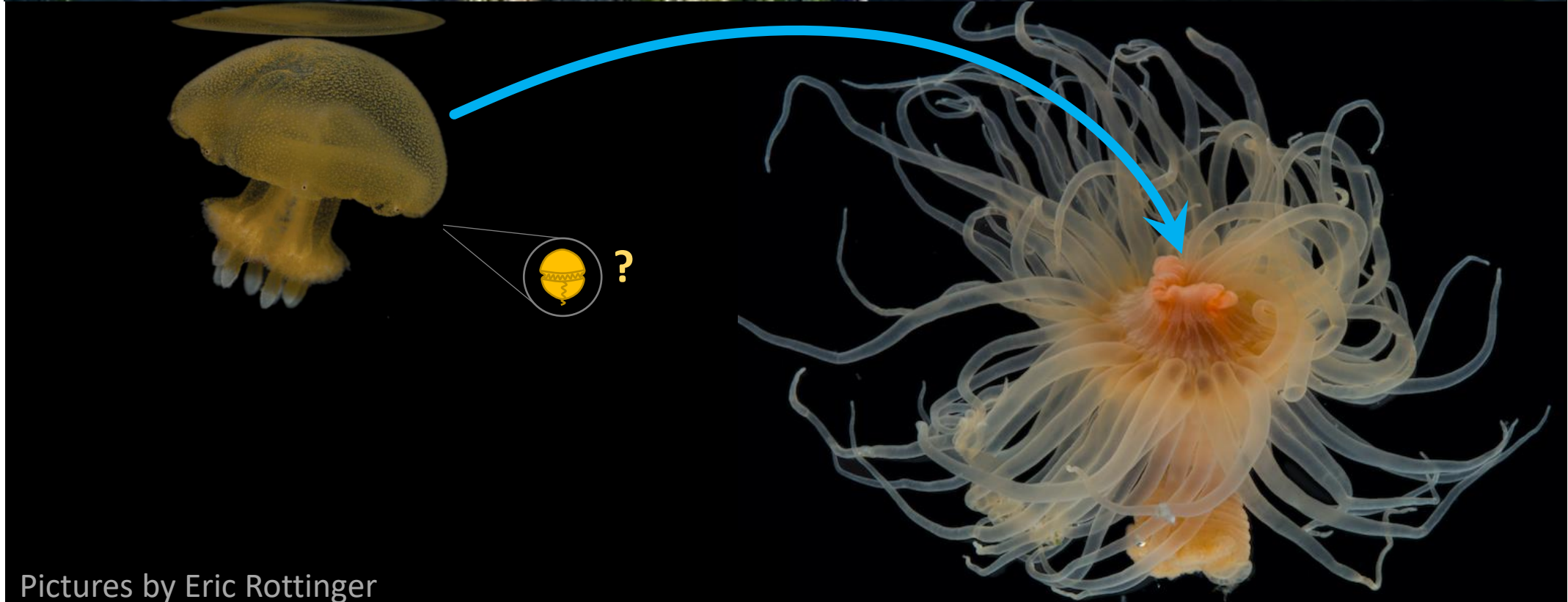
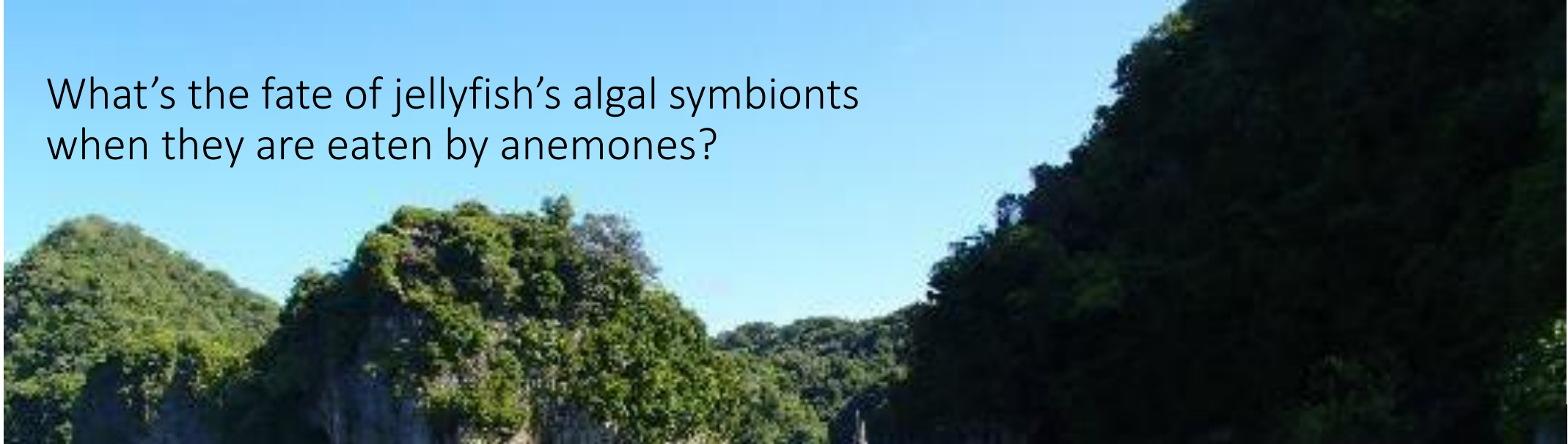


<https://www.flickr.com/photos/luxtonnerre/>



<https://coralreefpalau.org/research/marine-lakes/jellyfish-lake/>

What's the fate of jellyfish's algal symbionts when they are eaten by anemones?




Pictures by Eric Rottinger



Feeding an anemone with a jellyfish

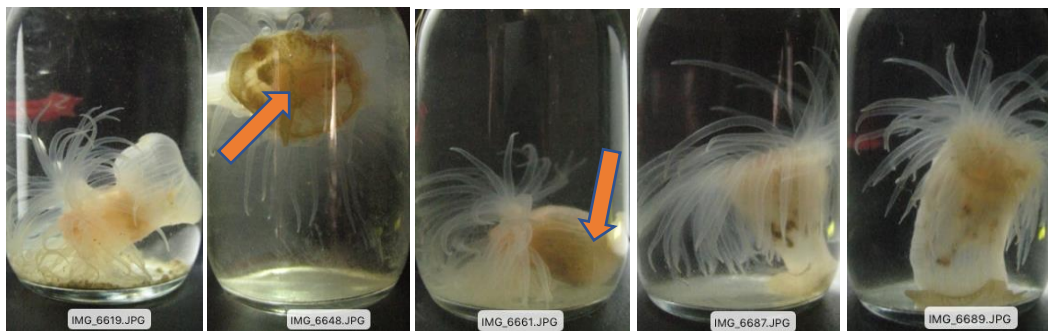
Uet era Ngermeuangel (Jellyfish lake)

Mastigias papua 

Ongeim'l Tketau (Jellyfish lake)

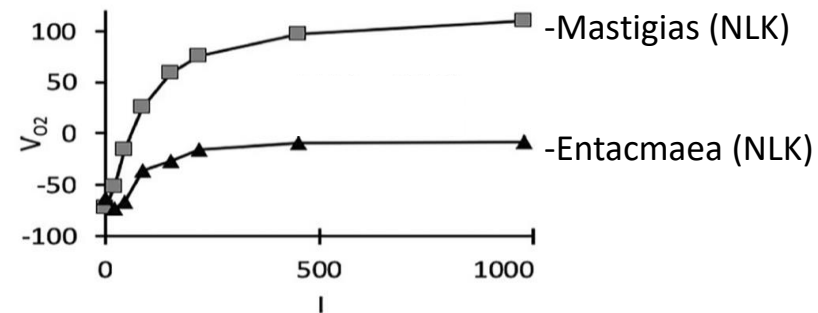
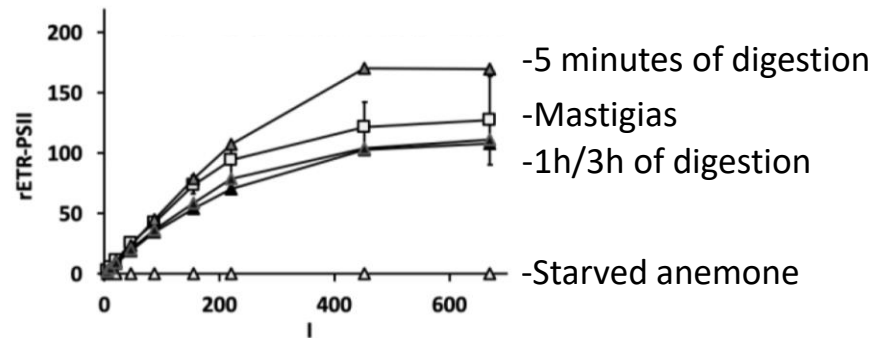
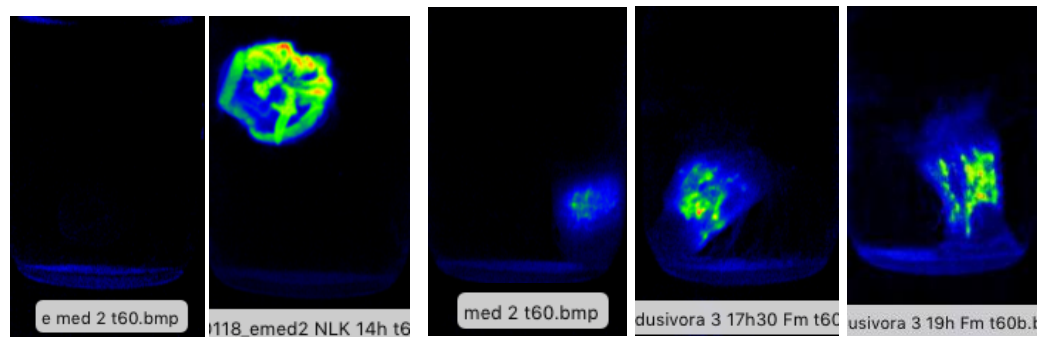
Entacmaea medusivora

True color picture

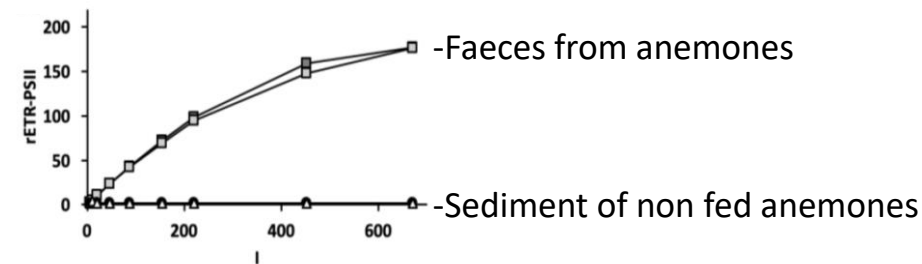
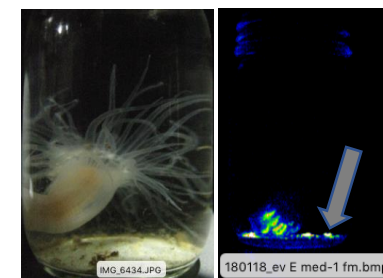


t=0h (JF in mouth) t=1h (JF in gut) t=3h t=4-5h

Chl *a* fluoresc

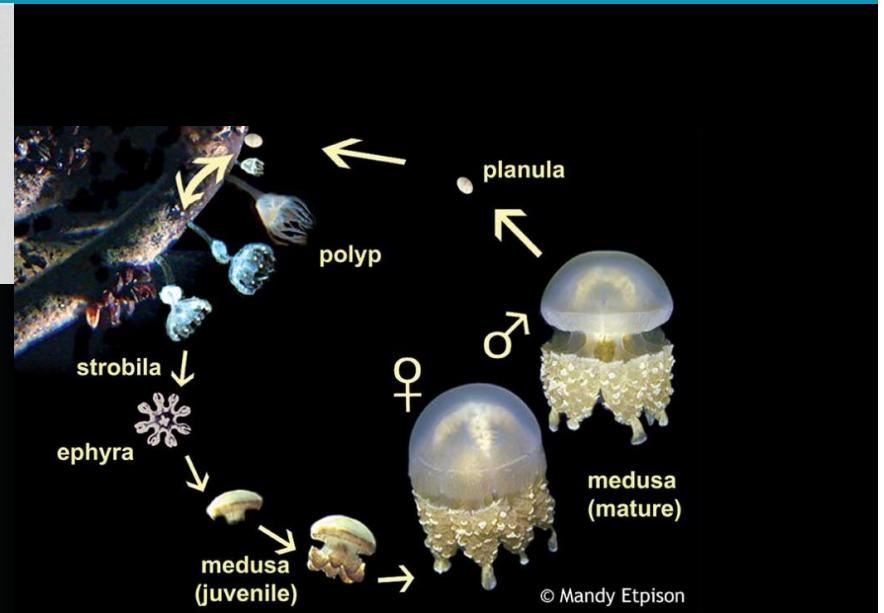
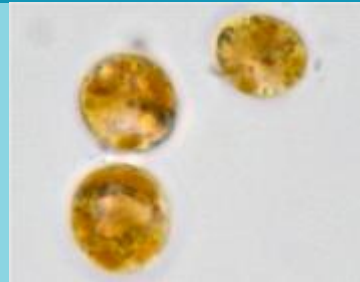
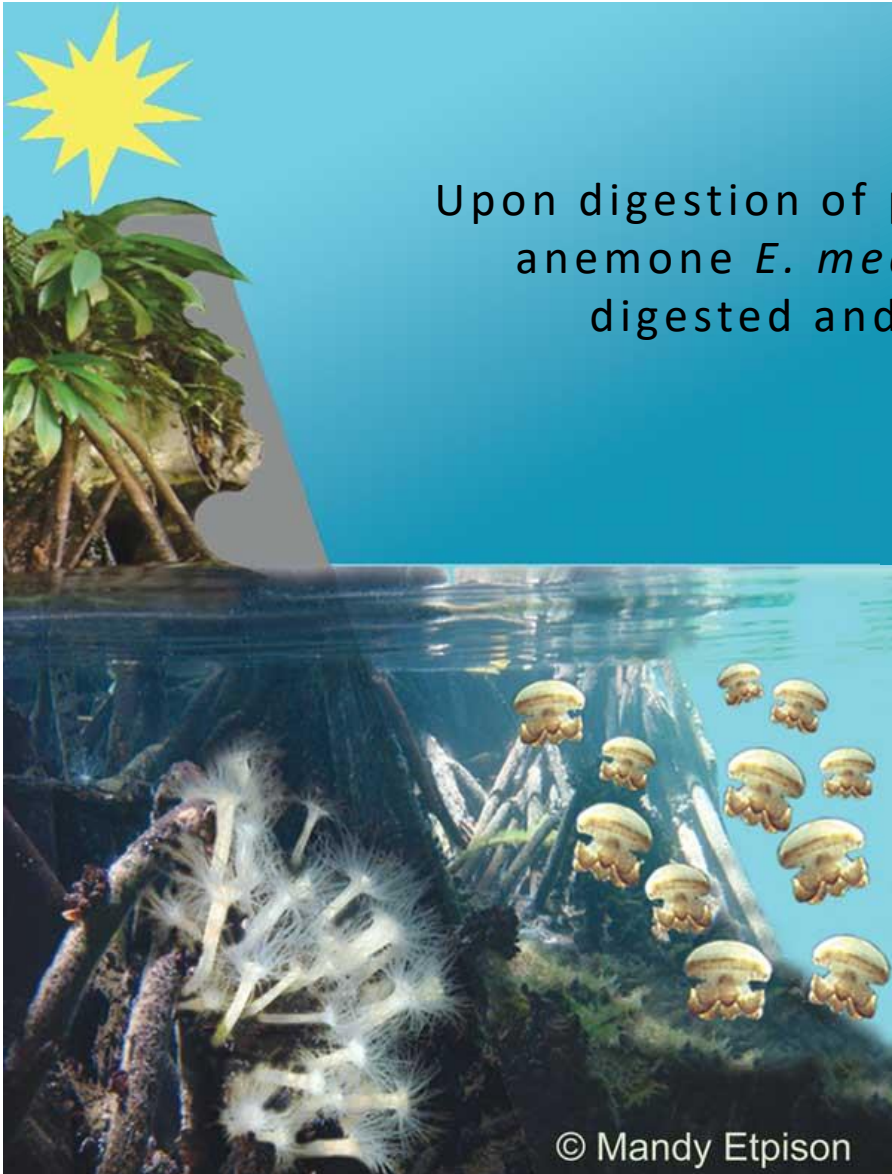


~12 h later



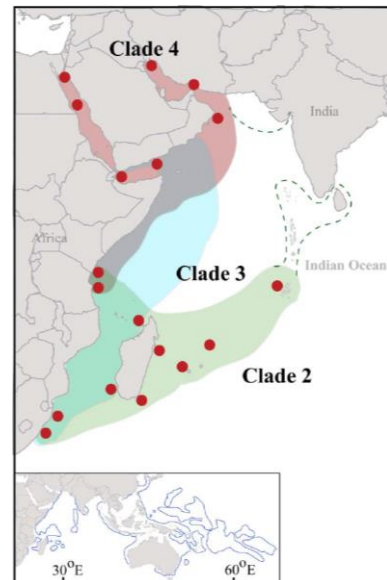
Upon digestion of photosynthetic jellyfishes *M. papua* by the anemone *E. medusivora*, *Symbiodiniaceae* cells are not digested and stay photosynthetically competent.

Vega de Luna et al., 2019. FEMS Microbiology Ecology, 95.



Biophysical analyses of bioenergetics on coral slices

Stylophora pistillata (Scleractinia, Anthozoa)





Colony growing in aquarium conditions

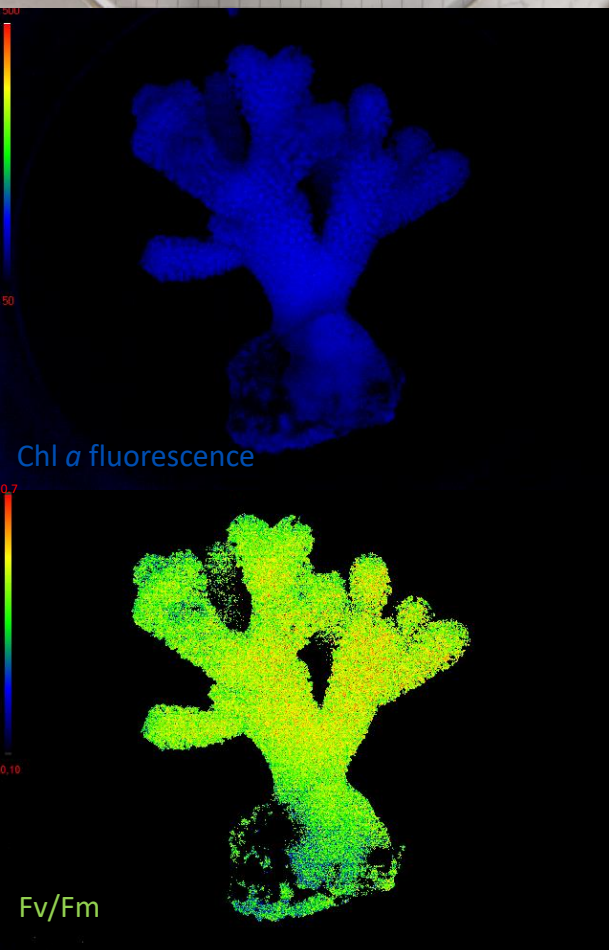
Stylophora pistillata (Milka variety) branch tips were cut to get small slices for spectroscopic measurements



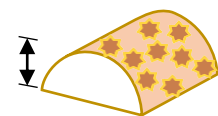
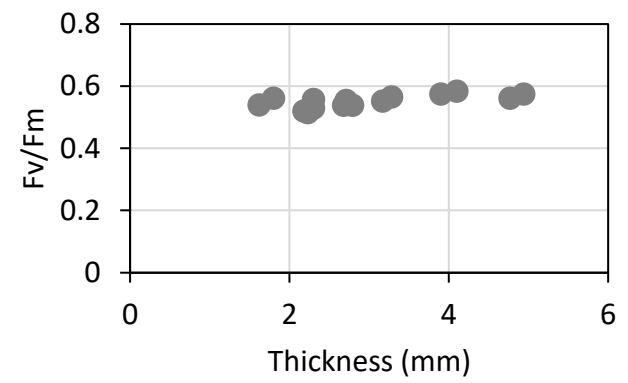
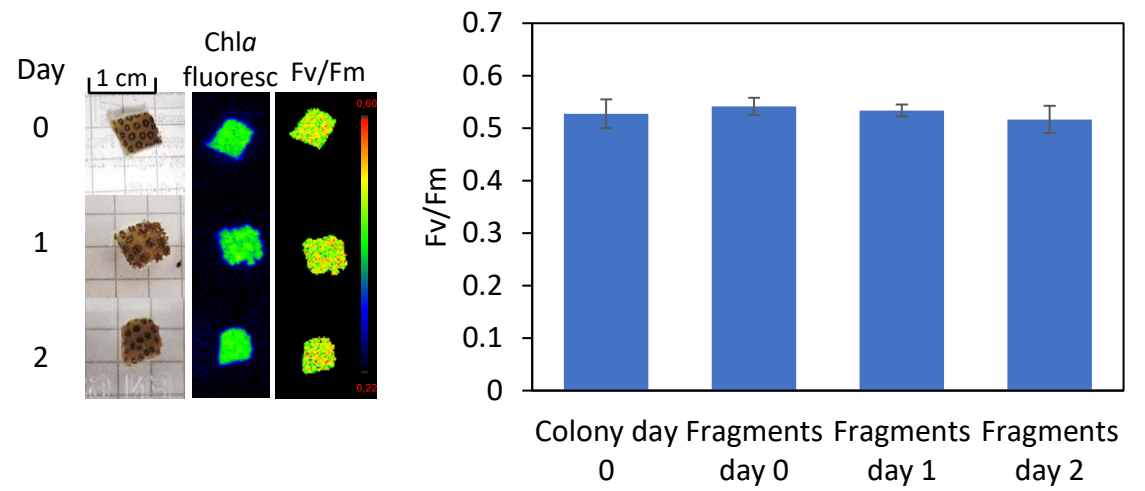
Coral slice



Aquarium

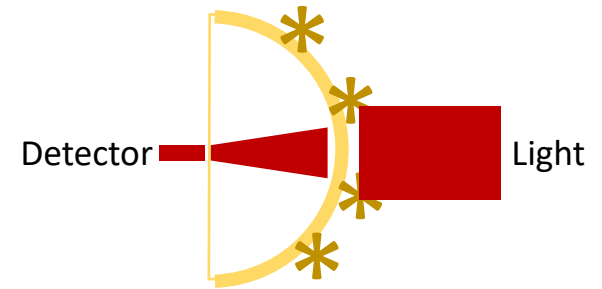
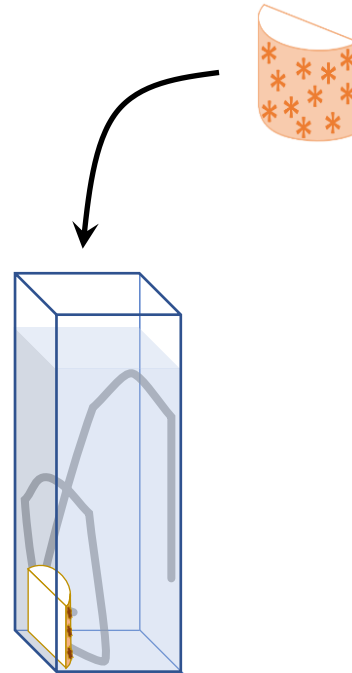
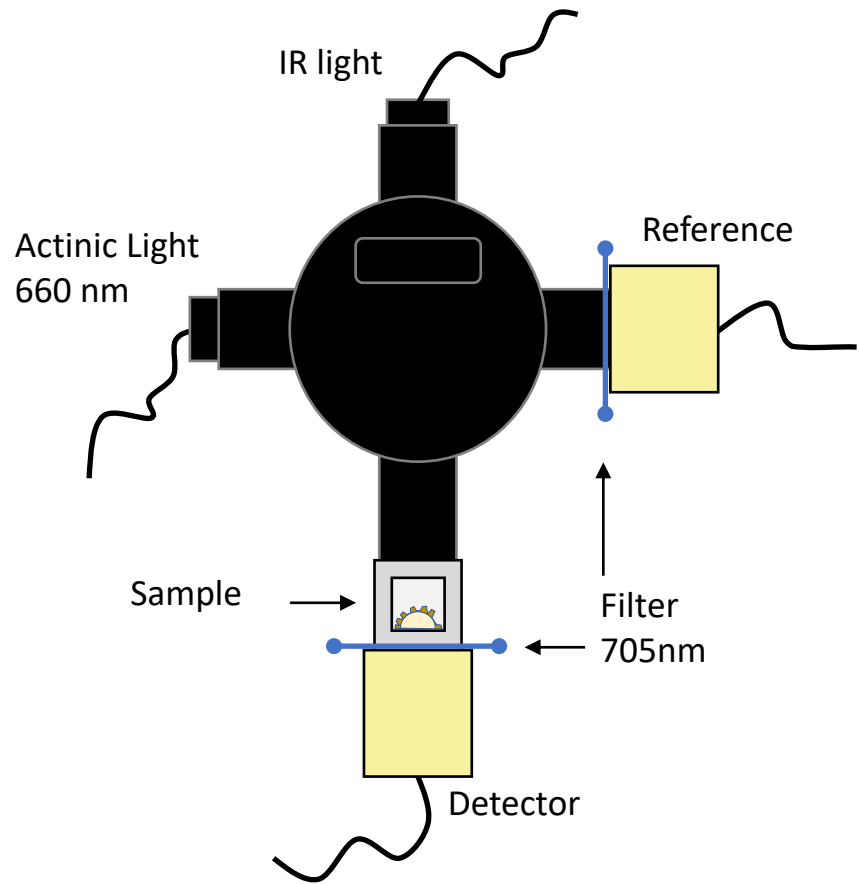


Fragments followed by Chl a fluorescence

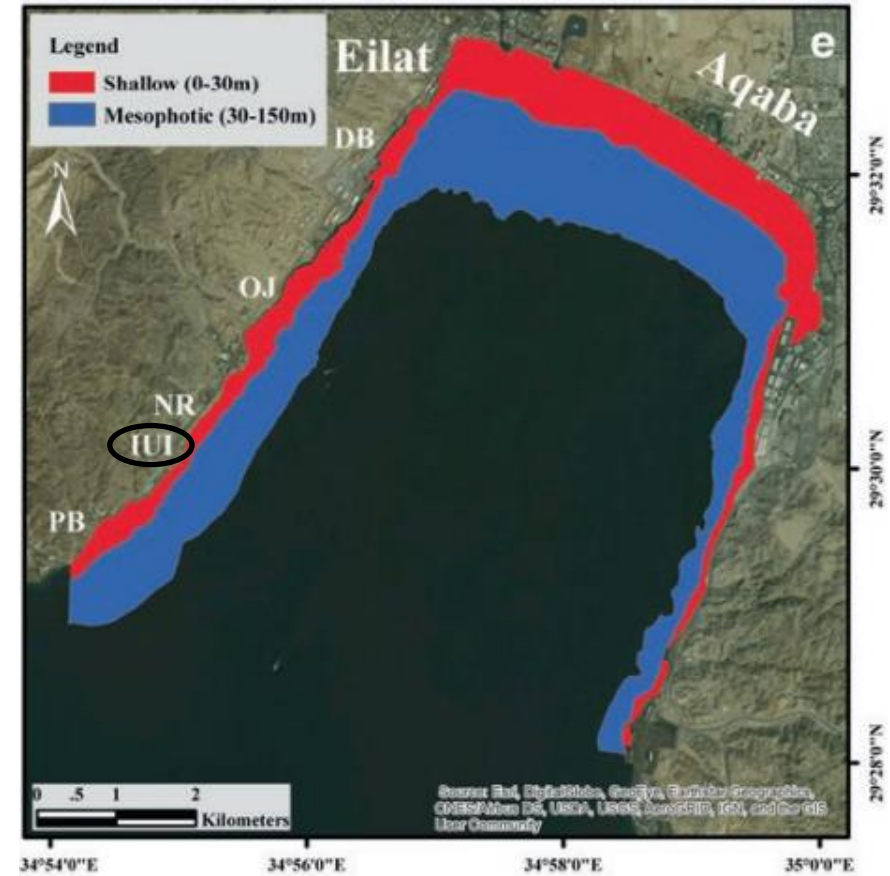
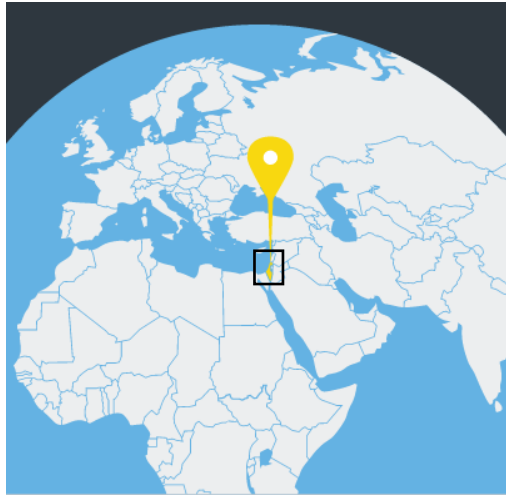


Measurement of PSI activity

Spectrophotometric measurements on coral slices



It is possible to analyze a small fraction of coral when inhibitors are needed



המכון הבינאוניברסיטאי למדעי הים באילת
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 iui@mail.huji.ac.il http://www.iui-eilat.ac.il/Default.aspx



Eyal et al., 2019 in Mesophotic Coral Ecosystems.





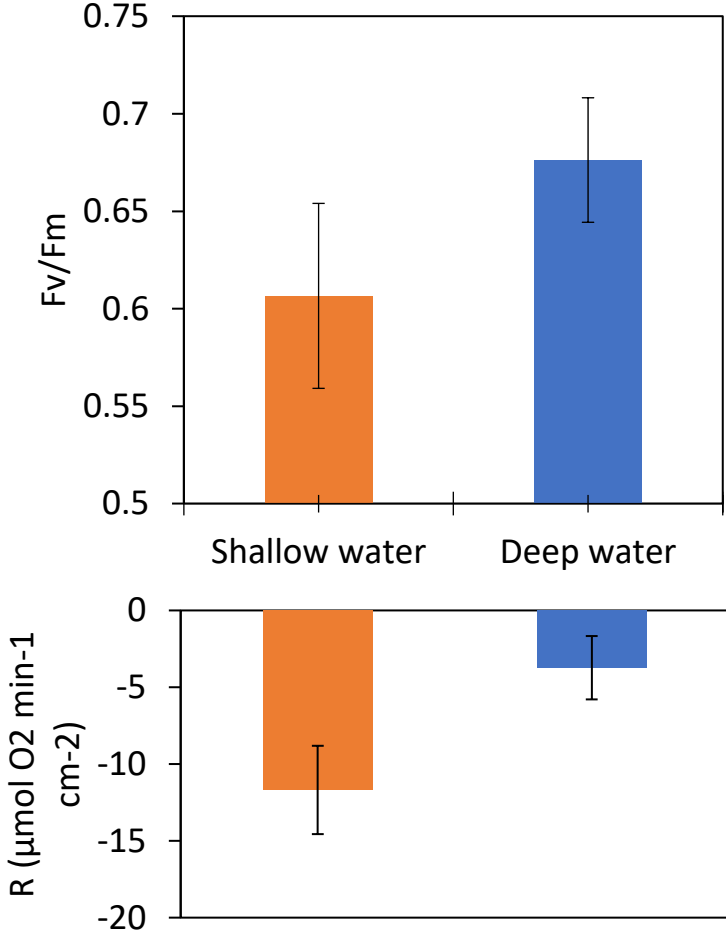


Corals collected at two different depths

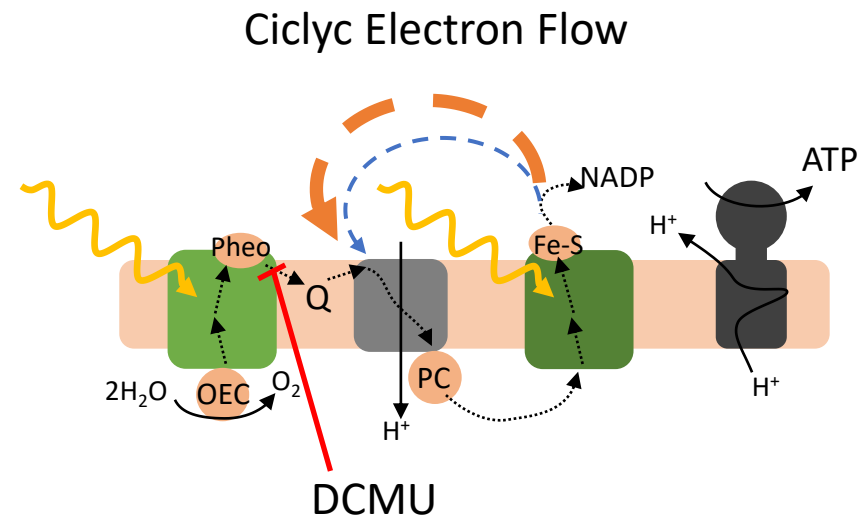
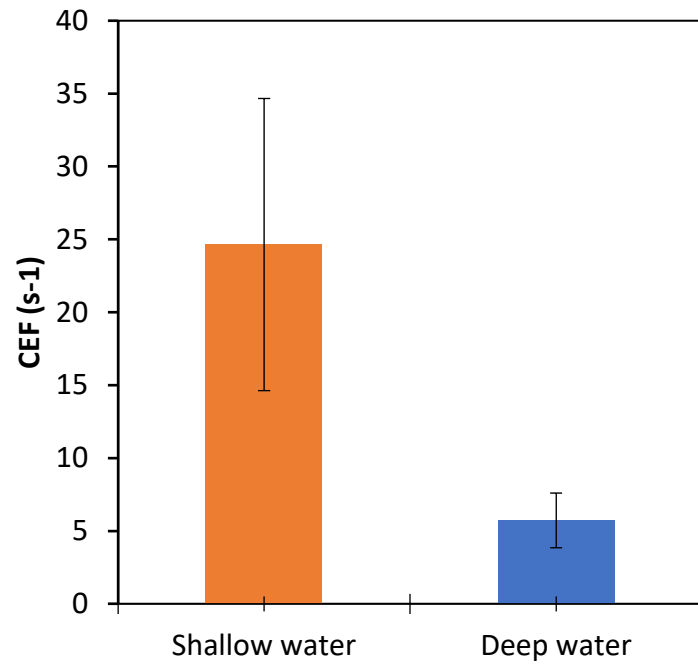


Shallow water coral
3-5 meters depth

Deep water coral
30-40 meters depth



Electron cycling at PSI level is more active in Shallow water corals



Main remarks

- Coral slices survive (up to 48hr) and do not suffer a noticeable consequence in aquarium conditions.
- Its optical properties allow spectroscopic measurement of photosynthetic processes.
- We revealed a higher CEF capacity in shallow water corals compared with deep water ones.



Take home message

- Typical and detailed photosynthetic *in vivo* analyses can be carried out in different photosymbiotic animals by sophisticated spectroscopic instrumentation



Thanks to Grant sources and laboratory team

Pierre CARDOL, PhD FRS-FNRS Senior Research Associate
Genetics and Physiology of Microalgae
Institute of Botany, B22
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Laboratoire de Physiologie Animale
et Écophysiologie, J-C. Plumier



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